(INCORPORATING THE LIVERPOOL BRANCH OF THE MA AND THE ATM)

OPEN CHALLENGE '19
SOLUTIONS

1. A STARTER FOR "?"

W H At, I S, 0 Ne, P Lu S, Ni Ne? = Te N = 52 7

2. "DOUBLE" DILEMMA

(a) Using Atomic numbers

$$\frac{(48 + 23 - 17)}{3} - \frac{48}{6} = 10 = \text{Neon}$$

(b) Interpreting the chemical symbols as Roman numerals

$$\frac{(CD + V - CL)}{LI} - \frac{CD}{C} = \frac{(400 + 5 - 150)}{51} - \frac{400}{100} = 1 = I = \text{Iodine}$$

3. ALL THAT GLITTERS

Let weight of gold be G oz and weight of silver be S oz

10lb = 160 oz

G+S = 160 (1)

$$\frac{52G}{1000} + \frac{99S}{1000} = 10$$

52G + 99S = 10 000 (2)

Solving gives

S = 35.74 oz (2dp)

G = 124.26 oz (2dp)

Therefore the crown was made from a mixture of gold and silver.

4. RINGING THE CHANGES

$Z \geq \frac{1}{2}T$, $Z \leq \frac{1}{3}C$ and $T+Z > 55$

Thus $C \geq 3Z = 2Z+Z \geq T+Z > 55$

Since Z must be an integer, the smallest value that 3Z can have is 57

Therefore C must be at least 57, not 56.

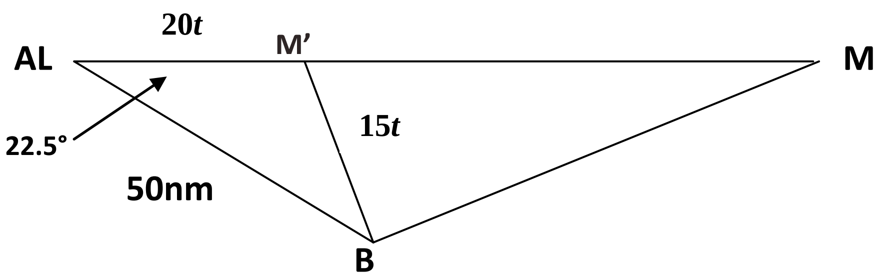
5. WAR ZONE MEDICINE

The minimum number of operations required is nine. There are two basic ways with minor variations in the first few moves.

6 fl oz	0	0	0	0	6	0	6	1	1	0	0	6	0	6	1	1	1	1
10 fl oz	0	10	0	5	5	5	5	10	1	10	0	0	6	6	6	10	0	10
15 fl oz	15	5	5	0	0	6	6	6	15	0	10	10	10	10	15	11	11	1

6. A NAUTICAL ELEMENT

Let AL be the Antoine Lavoisier and B be the Brimstone.
The ships will meet at M (or M') after a time *t* hours.

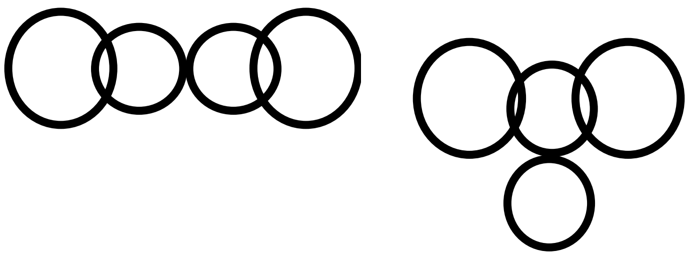


Using the cosine rule $(15t)^2 = (20t)^2 + 50^2 - 2 \times 20t \times 50\cos 22.5°$

$t = 1.593$ hours or 8.965 hours

7. LUSTROUS LINKS

There are two ways of attaching the platinum link and these will need to be considered separately. When you come to the second one (whichever order you do them in) the arrangements with the platinum link at the ends will be the same as in the first.



(a) 2 gold links not together.
9 links in a row, no restrictions so 9! = 362 880
But restriction on gold links so need to remove arrangements where gold links are together
Therefore consider them inseparably joined, giving only 8 links so 8!
But 2 gold links could be in order AB or BA, therefore x2 as arrangements, not design
Therefore need to subtract 8!x2
New number of arrangements now 9!-8!x2=8!x7= 282 240
Platinum link (figure 8) has 2 independent ends, therefore x2, so now 8!x7x2 = 564 480
Every link has 2 sides so each one can be attached in 2 ways
So for 9 links, $\{8!\text{x}7\text{x}2\}\text{x}2^9 = 8!\text{x}7\text{x}2^{10}$= 289 013 760
For any given arrangement, simply flipping the chain over through its entire length is not a different arrangement hence divide by 2
Also reversing the ends does not give a different arrangement so divide by 2 again
Answer therefore $8!\text{x}7\text{x}2^{10}/4 = 8!\text{x}7\text{x}2^{8}$=72 253 440

(b) 2 gold links not together and platinum link not at the end as the case where the platinum link is at the end is already counted in (a).
8 non-platinum links in a row, no restrictions so 8! = 40 320
7 possible places for platinum link so 8!x7 = 282 240
But restriction on gold links so need to remove arrangements where gold links are together
Therefore consider them inseparably joined, giving only 7 non-platinum links and 6 positions for platinum link so 7!x6
But 2 gold links could be in order AB or BA, therefore x2 as arrangements, not design
Therefore need to subtract 7!x6x2
New number of arrangements now 8!x7-7!x6x2 = 7!x44
Platinum link (figure 8) has 2 independent ends, therefore x2, so now 7!x44x2 = 443 520
Every link has 2 sides so each one can be attached in 2 ways
So for 9 links, $\{7!\text{x}44\text{x}2\}\text{x}2^9 = 7!\text{x}44\text{x}2^{10}$ =227 082 240
For any given arrangement, simply flipping the chain over through its entire length is not a different arrangement hence divide by 2
Also reversing the ends does not give a different arrangement so divide by 2 again
Answer therefore $7!\text{x}11\text{x}2^{10}$= 56 770 560

The jeweller could assemble the chain in a total of 129 024 000 ways.